IV.A Designated Bridge and Agent Bridge

Each LAN has a *designated bridge* and this bridge is also the designated bridge of all end stations attached to that LAN. The designated bridge of an end station *s* to is designated to be *db(s)*. A designated bridge may be an old bridge or a STAR bridge.

If an end station can be mapped to its "closest" STAR bridge, as the distance vector is correct, the bridges will forward the frame according to a STAR forwarding path. This is called this "closest" bridge the *agent* bridge of the end station. This agent bridge must be a STAR bridge for the BF Table contains STAR bridges only. Once a STAR bridge identifies itself to be an agent bridge of a formerly unknown end station, it is responsible to tell other bridges so that they know where to forward a frame destined for that station. This can be done by using Station Location Announcement SBPDU frames. For convenience, we refer a Station Announcement SBPDU frame as a *StationLoc* frame. The destination address of all StationLoc frames is the multicast address of bridge group *B*. Let the format of a StationLoc frame be *<end station address, agent bridge ID>*. The expression *ESL(n, s)* represents *ab(s)* in the ESL Table of *n*.

The designated bridge is a suitable candidate to be an agent bridge if it is a STAR bridge. If the designated bridge is a STAR bridge, it can announce itself to be the agent bridge. However, an old bridge does not do that. As a result, we need to find a STAR bridge that is reasonably close to the old, designated bridge of the end station to be the agent. When an old bridge forwards a data frame, it may send it to more than one child link but at most one root link. Therefore, it would be undesirable to have a STAR bridge on the downstream to be an agent for we may end up having more than one agent. Among all the STAR bridges along the upstream, the one closest to the old bridge is preferred. However, there are situations that no agent bridge is identified. For example, if the designated bridge is the root that is an old bridge, all the STAR bridges will be on downstream and so no bridge will declare as the agent bridge. In that case, the tree path is used for forwarding and we record the forwarding port in the FD as what the old bridges do. We say the agent bridge is *undefined* for an end station if there is no bridge declared as the agent. In other words, the agent bridge is *unknown* to all STAR bridges.

IV.B End Station Location Table

Each entry in the ESL Table of STAR bridge *n* is a tuple *(s, ab(s))* where *s* is an end station and *ab(s)* is the agent bridge of *s*. Each such entry in the ESL Table of *n* is created when an unknown end station is newly discovered by *n*. Each entry in the FD of STAR bridge *n* indicates a forwarding port of *n* for an end station *s*, that is *f(n, s)*. Each such entry in the FD of *n* is created when an unknown end station is newly discovered by *n*.

The STAR learning process of STAR bridges is responsible for filling out these entries. STAR bridge *n* fills out the ESL Table using the information in the StationLoc frames received. The FD can be filled as in the IEEE 802.1D standard, in which case *n* records the port from where a normal data frame arrives. The set of end stations in the ESL Table of *n* is *H(n)* and the set of end stations in the FD of *n* is *S(n)*.

An end station *s* is referred to as a *known* end station with respect to *n* if $s \in H(n) \cup S(n)$; *s* is *unknown* otherwise. Note that, after timing out old entries in the FD, $H(n) \cap S(n)$ is a set of end stations where the agent bridge of each of the end stations is *n*. In addition to filling out the ESL Table and FD, *n* should be able to identify whether it is the agent bridge of an end station *s* when a normal data frame from *s* is received.

IV.C Procedures for STAR Learning Process

Whenever a STAR bridge is in the Enhanced state, it executes the STAR Learning process. The bridge invokes a SLA_SBPDU_Proc procedure upon receiving a StationLoc frame, and a DF_STAR_Learning_Proc procedure upon receiving a normal data frame. The pseudocodes for these procedures are shown in Pseudocode 5 and Pseudocode 6 respectively. In both pseudocodes, whenever an entry in the ESL Table or the FD is updated or created, its corresponding timer is reset. FIG. 18 and FIG. 19 show the flow-charts corresponding to Pseudocode 5 and Pseudocode 6 respectively.

The SLA_SBPDU_Proc procedure is used by a STAR bridge to update its ESL Table and to propagate agent bridge information to its STAR neighbors. Specifically, upon receiving a StationLoc(*s*) frame <*s*, *k*> from tree port *p*, a STAR bridge *self* assigns *k*, the agent bridge of *s*, to *ESL(self, s)*, and then forwards the StationLoc(*s*) out of all its tree ports except *p*.

The DF_STAR_Learning_Proc procedure is used by a STAR bridge to update its FD and ESL Table upon receiving a normal data frame *fr*. The procedure is also used by the STAR bridge to discover if it is an agent bridge for *src(fr)*, and if so, the STAR bridge forwards a StationLoc(*src(fr)*) out of appropriate tree ports.

As specified in Pseudocode 6, when *self* is the designated bridge but not the agent bridge of the source end station *s* (Case 6.1), it sends a StationLoc(*s*) frame on all tree ports and updates the FD entry and ESL Table entry for *s*. If *ab(s)* is unknown (Case 6.2), *self* has to check whether it is *ab(s)*. If $ab(s) \neq db(s)$, then *ab(s)* is the closest upstream STAR bridge and so *ab(s)* must receive the normal data frame of *s* from a child link port (Case 6.2a). The agent bridge sends the StationLoc(*s*) frame on all tree ports. Therefore, those STAR bridges in higher levels of the spanning tree will receive the StationLoc(*s*) frame before the normal data frame. They should have an entry for *s* in their ESL Tables by the time they receive the normal data frame and won't send out another StationLoc(*s*) frame.

PROCEDURE: SLA_SBPDU_Proc(*s*, *k*, *p*), see also Fig. 9

```
Begin
        ESL(self, s) := k;                              /* fill the ESL Table */
        Send StationLoc(s) frame on all tree ports except p
end
```

Pseudocode 5: SLA_SBPDU_Proc

```
PROCEDURE: DF_STAR_Learning_Proc(fr, p), see also Fig. 18
/* fr is a normal data frame */
Begin
    s := src(fr)
    If db(s) = self and ab(s) ≠ self          /* Case 6.1: self is the designated bridge
                                                 and current agent bridge is not self */
        Send StationLoc(s) <s, self> frame on all tree ports
        f(self, s) := p;
        ESL(self, s) := self
    Else if ab(s) is not found                /* Case 6.2: agent bridge not known */
        If p is a child port                  /* Case 6.2a: p is a child link port */
            Send StationLoc(s) <s, self> frame on all tree ports
            f(self, s) := p;
            ESL(self, s) := self
        Else if p is a root port
            f(self, s) := p
end
```

Pseudocode 6: DF_STAR_Learning_Proc

V. STAR forwarding process

STAR bridges execute the STAR forwarding process after the STAR learning process when a data frame is received. Having received a data frame destined for an end station *t*, a STAR bridge *n* first checks its ESL Table to determine if it knows *ab(t)*, the agent bridge of *t*. If *ab(t)* is found, *n* will then find out from its BF Table the forwarding port of *ab(t)*. If no entry for *ab(t)* is found in the BF Table, the data frame is dropped because it indicates an error in the BF Table. Since the agent bridge is a STAR bridge, the BF Table should have a record showing how to get there. If *ab(t)* is unknown, *n* will proceed to check its FD. If end station *t* is unknown, STAR bridge *n* will forward the data frame on all tree ports except the incoming one, just as the IEEE 802.1D standard.

V.A Frame Duplication Problem

In the IEEE 802.1D standard, although a bridge may forward the same frame on more than one port, only one port leads to the destination and the designated bridge of the destination since there is a unique path from any source to any destination on a spanning tree. Therefore, an old bridge can never receive the same data frame more than once. As the STAR bridge graph may not be a tree, two STAR bridges may receive the same data frame and try to forward it to the destination using different paths. For example, suppose that the destination end station is attached to *u'* and the source end station is